XVI. *Two remarkable forms of* Mantid oothecae. By R. Shelford, M.A., F.L.S., F.Z.S.

[Read October 20th, 1909.]

Plate XVII.

In a miscellaneous collection of insects formed by the late Mr. F. P. Pascoe and recently presented to the Hope Department, Oxford University Museum, by Miss Pascoe, was found a box containing five Mantid oothecae from Delagoa Bay. These specimens, together with an ootheca found at Chamicuros, Peruvian Andes, by the late Edward Bartlett and now in the Oxford Museum,* are so unlike the usual type of Mantid egg-case, that descriptions and figures of them will not be without interest.

The East African specimens, which vary considerably in size (30 mm.—15 mm. in length × 14 mm.—12 mm. in diameter), are semi-transparent, bladder-like structures, elongate-oval to almost spherical in shape and straw-yellow in colour. Each is attached by a slender ring of parchment-like consistency to the twig of a plant. The substance forming the walls of an ootheca also resembles very thin parchment and is in direct continuity with the attaching ring; its surface is seen to be finely reticulated, an appearance that is due to the inclusion of air-bubbles in this dried and hardened secretion of the thecogenous glands. The oothecae are firmly attached and stand out from the twigs at varying angles. Along the middle line on the upper surface of the ootheca there runs a well-defined ridge. This ridge is made up of a double series of empty cells, 70 to 40 in number, open at the top but closed at the bottom, so that they do not communicate with the interior of the ootheca. The outer walls of these cells are higher than the inner walls, the ridge, consequently, when viewed from above, appears to be grooved; the inner cell-walls of one series interdigitate with the inner cell-walls of the other series in a perfectly regular and sym-

* The South American specimen bears the label "♂, ♀ and nest," but I have not been able to find the insects in the Hope collection of Mantidae.

metrical way. When an ootheca is cut open a septum will be seen dividing the oothecal cavity almost completely into a right and left half; it extends inwards from immediately below the ridge on the upper surface of the oothecal wall towards the opposite wall, which, however, it does not reach. The septum is a homogeneous vesicular membrane of no great thickness but quite opaque; its free border is irregular in outline. The eggs are placed in 15 to 20 rows on either side of the septum with their long axis at right angles to it and with the heads of the embryoes directed outwards; they form two compact masses which do not cover the whole of the septum but only about a third of its surface, extending from the free border towards the line of attachment. In one of the larger oothecae there are 136 eggs situated on one side of the septum and apparently an almost equal number are to be found on the other side. There is no information accompanying the specimens, so that it is not possible to say if they were made by a single or by more than one individual.

The South American specimen is rather different in appearance from the Delagoa Bay examples, though it is built on essentially the same plan. It is almost a perfect sphere, 15 mm. in diameter, hollow, dark green in colour and semi-transparent; its walls are quite smooth with the exception of inconspicuous reticulations, and there is no ridge as in the African specimens. The ootheca is borne on a slender tubular stalk, and no doubt this was originally attached to a twig, but it has been cut by the collector so that the method of attachment cannot be determined now. In the centre of this hollow sphere is an imperfectly spherical mass of densely vesicular material like dried foam in appearance. About 80 eggs are embedded in this mass, they are set close together with the anterior pole directed outwards and their arrangement is, roughly speaking, radiate. This central egg-mass is attached to the outer wall of the ootheca by a thin septum which incompletely divides the ootheca into two halves; the line of attachment of this septum corresponds to that of the septum in the East African oothecae and undoubtedly the two structures are homologous. A few fragile strands of dried foam help to moor the central egg-mass to the surrounding wall of the ootheca.

The accompanying diagrammatic figures of transverse

sections through the two oothecae, together with the photographs, should make clear anything that is at all obscure in the foregoing description.

These two forms of Mantid oothecae differ radically from all those that have previously been described on account of their hollow nature, whereby the enclosed mass of eggs

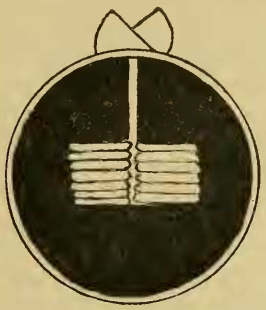

Fig. 1.—Diagrammatic transverse section of the ootheca from Delagoa Bay.

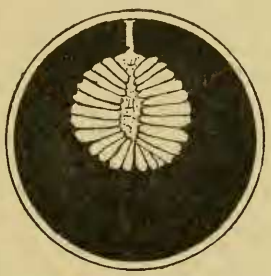

Fig. 2.—Diagrammatic transverse section of the ootheca from the Andes.

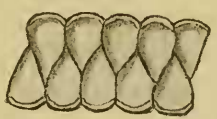

Fig. 3.—Portion of the grooved ridge of the Delagoa Bay ootheca viewed from above.

is surrounded by an empty air-space. Thanks to the admirable researches of Giardina * we are acquainted with the structure and method of formation of the ootheca of the European Mantis, *M. religiosa*. In this species—and it is probable that in nearly all the *Mantinae* the structure of the ootheca is essentially similar—the eggs are enclosed in a double series of thin-walled cells; the cells, except a few at the anterior and posterior ends of the ootheca, are practically divided into an internal and an external half; the former contain the eggs, the latter are empty and together form a thick spongy layer protecting the inner core of eggs. Each egg-cell communicates with the exterior by a narrow passage, opening on the upper surface

* Natural. Siciliano (N.S.), Anno II, and Giorn. Soc. Sci. Nat. Econ. Palermo, XXII (1899).

of the ootheca, which here presents a double series of imbricating scales; these scales are in reality the free ends of the lamellae which form the walls of the egg-cells and between them lie the passages to the interior of the egg-cells. The young larvae, when ready to emerge, have merely to push their way along the "canali di uscita," as Giardina terms them, in order to gain access to the outer world. This is a very bald description of an extremely complicated structure, but it suffices for my present purpose, and readers anxious for further details must consult Giardina's two memoirs. The nests of species of *Ameles* are described by the same authority; they chiefly differ from that of *Mantis religiosa* by the presence of a grooved ridge apparently very like that in the East African oothecae here described; at the bottom of the ridge occurs the double row of the openings of the "canali di uscita." The ridge, in fact, is strictly homologous with the double row of imbricating scales in the nest of *Mantis* and is formed by the free ends of the lamellae composing the walls of the egg-cells. I will return to this point later.

The ootheca of *Gongylus gongylodes* (sub-fam. *Empusinae*) has been described in some detail by Captain C. E. Williams in the Transactions of this Society for 1904, pp. 129–131, and I need not allude further to this excellent piece of work beyond remarking that the egg-cells are not protected by a surrounding spongy layer of empty cells but by a layer of hardened foam only $\frac{1}{8}$ in. thick; the young larva "softens the end of the cell in which it lies, and this falls outwards as a small disc hanging by a silk thread," and the larva is now free to walk out of its prison. The ootheca of *Hymenopus bicornis* (sub-fam. *Harpaginae*) is very like that of *Gongylus* and the emergence of the larvae is effected in the same manner.

Turning now to the Blattidae, which are more nearly related to the Mantidae than is any other family of the Orthoptera,* we find that the ootheca of a species such as *Blatta orientalis* is a chitinous capsule in which the eggs are tightly packed; when the larvae are ready to emerge either by their movements or perhaps by the action of a cephalic ampulla (cf. Mlle. Pavlova, Zool. Anz., 1895, p. 7)

* Handlirsch (Die fossilen Insekten, p. 1290) regards the Blattidae and the Mantidae as orders of the sub-class *Blattaeformia*, and the Acridiidae + Locustidae + Gryllidae, the Phasmidae and the Dermaptera as orders of the sub-class *Orthopteroidea*.

the sides of the capsule are forced apart and the larvae are liberated.

But the larvae of the *Mantidae* that formed the remarkable oothecae described in this paper, when they throw off their egg membranes are in very different case, for they find themselves in a relatively vast and empty space, the walls of which are both tough and smooth. They can find no *point d'appui* whence they can exert pressure on the oothecal wall, and it is difficult to see how with their tender mandibles they can gnaw their way through this resistant tissue. At one time I was inclined to believe that the ridge on the East African oothecae was a line of dehiscence and marked, so to speak, the line of least resistance in the structure. But this is not so, the ridge is the toughest part of all, and even if it was a line of dehiscence, where is this line in the South American specimen? For the release of the larvae, then, either the bladder-like oothecae must crack open at the propitious moment, or, as appears more probable, the larvae are provided with some special organ that enables them to pierce or rasp a way through the walls of their prisons.

The grooved ridge on the East African ootheca deserves another word of notice. Superficially it resembles the grooved ridge on the ootheca of *Ameles* and might be regarded as formed in a similar way. But this cannot be so. The ridge of the ootheca of *Ameles* is the product of the free ends of the lamellae forming the walls of the egg-cells; as each cell is made and each egg laid a portion of the ridge is formed and its construction proceeds *pari passu* with the growth in size of the ootheca. It is plain, therefore, that each element or division of the ridge is in direct relation with an egg and egg-cell. The ridge in the African oothecae is, as stated, made up of a double series of compartments, but these compartments bear no relation to the internal structure of the ootheca. The septum is homogeneous and shows no trace of the segmental arrangement characteristic of the internal structure of the ootheca of other Mantidae. Moreover, the eggs not only lie at right angles to the direction of the ridge, instead of in the same plane as in *Ameles*, but are also much more numerous than the compartments of the ridge, and the number of rows in which they are arranged is less than the number of compartments. It seems, then, almost certain that this grooved ridge is functionless as

regards the emergence of the larvae, so that if it is the morphological equivalent of the grooved ridge in *Ameles* ootheca and of the imbricating scales of *Mantis* oothecae—and I am by no means convinced that this is the case—it is certainly not the physiological equivalent of those structures. The sequence of events in the construction of the African oothecae can, in the absence of direct observations, only be guessed at. The first part to be formed is evidently the attaching ring, then on this is built in a semicircular sweep the grooved ridge, to which is fixed the septum with the eggs; the final stage in the process is probably the formation of the thin enveloping wall. Such may or may not be the sequence of events—an hour's observation of the living insect at work can upset the most closely-reasoned theory formed in the museum or laboratory. It is noteworthy that neither in the African nor South American oothecae are the eggs enclosed in separate cells.

Bilateral symmetry, which is so marked a characteristic of all Mantid oothecae, is clearly distinguishable in the African egg-cases here described, but is scarcely to be distinguished in the South American specimen owing to its spherical shape and to the radiate arrangement of the eggs; the position of the septum is the only feature that remains to show that this ootheca is derived from a bilaterally symmetrical form.

A much reduced figure of an ootheca from the Egyptian Sudan, closely resembling those described above from Delagoa Bay, is figured on Plate II of SitzB. Kais. Akad. Wiss. math. naturw. Klasse cxvi, Abt. 1 (1907); it was taken at Gondokoro by Dr. Fr. Werner. There is no mention of it in the text.

Explanation of Plate XVII.

[*See Explanation facing the* Plate.]

Dec. 31, 1909.